New Hampshire Volunteer Lake Assessment Program

2003 Biennial Report for Partridge Lake Littleton

NHDES
Water Division
Watershed Management Bureau
29 Hazen Drive
Concord, NH 03301

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **PARTRIDGE LAKE, LITTLETON,** the program coordinators have made the following observations and recommendations:

We would like to congratulate your group on sampling twice this season! However, we would like to continue to encourage your group to conduct more sampling events in the future. Typically we recommend that monitoring groups sample three times per summer (once in June, July, and August). We understand that the number of sampling events you decide to conduct per summer will depend upon volunteer availability, and your monitoring group's water monitoring goals and funding availability. However, with a limited amount of data it is difficult to determine accurate and representative water quality trends. Since weather patterns and activity in the watershed can change throughout the summer, from year to year, and even from hour to hour during a rain event, it is a good idea to sample the lake/pond at least once per month over the course of the season.

If you are having difficulty finding volunteers to help sample, or to pick-up or drop-off equipment at one of the laboratories, please give the VLAP Coordinator a call and we will try to help you work out an arrangement.

We would like to encourage your monitoring group to participate in the DES Weed Watchers program, a volunteer program dedicated to monitoring the lakes and ponds for the presence of exotic weeds. This program only involves a small amount of time during the summer months. Volunteers survey their waterbody once a month from June through September. To survey, volunteers slowly boat, or even snorkel, around the perimeter of the waterbody and any islands it may contain. Using the materials provided in the Weed Watchers Kit, volunteers look for any species that are of suspicion. After a trip or two around the waterbody, volunteers will have a good knowledge of its plant community and will immediately notice even the most subtle changes. If a suspicious plant is found, the volunteers will send a specimen to DES for identification. If the plant specimen is an exotic, a biologist will visit the site to determine the extent of the problem and to formulate a plan of action to control the nuisance infestation.

If you would like to help protect your lake or pond from exotic plants, contact Amy Smagula, Exotic Species Program Coordinator, at 271-2248 or visit the Weed Watchers web page at www.des.state.nh.us/wmb/exoticspecies/survey.htm.

The Partridge Lake Diagnostic Study report and recommendations has been fully drafted and is in the process of going through internal review. It is hoped that the project report will be released sometime the Summer, of 2004. The study report will fully detail explanations of the data and findings from the study, and will make recommendations about remedial and rehabilitation efforts that should be taken. These next steps will involve partnerships between the Lake Association, Town of Littleton, and various state agencies, including DES. Management strategies are aimed at managing the Partridge Lake watershed and reducing sources of elevated nutrient inputs to the lake, and then addressing in-lake problems, including internal phosphorus loading from the sediments.

We thank the Lake Association and the Town of Littleton for their continued patience during the drafting and review of this project. Please contact Amy Smagula at NH DES at asmagula@des.state.nh.us or 271-2248 with specific questions or concerns

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake/pond has been monitored through the program.

  Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. **The mean (average) summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 7.02 mg/m^3.**

  The current year data (the top graph) show that the chlorophyll-a concentration ***increased*** from June to August. The chlorophyll-a concentration in June was ***less than*** the state mean and in August was ***greater than*** the state mean.

The historical data (the bottom graph) show that the 2003 chlorophyll-a mean is ***approximately equal to*** the state mean. Overall, the statistical analysis of the historical data (the bottom graph) shows that the mean annual chlorophyll-a concentration has ***not significantly changed*** (either *increased* or *decreased*) since monitoring began in **1989**. Specifically, the chlorophyll-a concentration has remained ***relatively stable*** and has been ***approximately equal to*** the state median. (Note: Please refer to Appendix E for the detailed statistical analysis explanation and data print out.)

While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes/ponds, phosphorus is the nutrient that algae depend upon for growth. Algal concentrations may increase with an increase in nonpoint sources of phosphorus loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). Therefore, it is extremely important for volunteer monitors to continually educate residents about how activities within the watershed can affect phosphorus loading and lake/pond quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake/pond transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the lake/pond has been monitored through the program.

  Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. **The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.**

  The current year data (the top graph) show that the in-lake transparency ***remained stable*** from June to August. The transparency in both months was ***approximately equal to*** the state mean.

  The historical data (the bottom graph) show that the 2003 mean transparency is ***approximately equal to*** the state mean.

  Overall, the statistical analysis of the historical data (the bottom graph) show that the mean annual in-lake transparency has ***not***

significantly changed (either *increased* or *decreased*) since monitoring began in **1989**. Specifically, the in-lake transparency has remained ***relatively stable*** and has been ***greater than*** the state mean. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

Typically, high intensity rainfall causes erosion of sediments into lakes/ponds and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from DES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake/pond has joined the program.

  Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

  The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration ***remained stable*** from June to August. The phosphorus concentration in both months was ***approximately equal to*** the state median.

  The historical data show that the 2003 mean epilimnetic phosphorus concentration is ***approximately equal to*** the state median.

  The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***increased*** from June to August. The phosphorus was ***greater than*** the state median.

  The historical data show that the 2003 mean hypolimnetic phosphorus concentration is ***greater than*** the state median.

Overall, the statistical analysis of the historical data show that the phosphorus concentration in the epilimnion (upper layer) has ***not significantly changed*** (either *increased* or *decreased*) since monitoring began in **1989**. Specifically, the phosphorus concentration in the epilimnion and hypolimnion has remained ***relatively stable*** and has been ***approximately equal to*** the state median. (Note: Please refer to Appendix E for the statistical analysis explanation and data print out.)

Overall, the statistical analysis of the historical data show that the phosphorus concentration in the hypolimnion (lower layer) has ***significantly increased*** since monitoring began. Specifically, the phosphorus concentration in the hypolimnion has ***increased*** (meaning ***worsened***) on average at a rate of approximately **7.4 percent** per season during the sampling period **1989** to **2003** (Please refer to Appendix E for the statistical analysis explanation and data print out).

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands.

TABLE INTERPRETATION

- **Table 2: Phytoplankton**

  Table 2 (Appendix B) lists the current and historic phytoplankton species observed in the lake/pond. The dominant phytoplankton species observed in June of this year were ***Rhizosolenia*** **(a diatom),** ***Dinobryon*** **(a golden-brown),** ***and Synedra*** **(a diatom).**

  Phytoplankton populations undergo a natural succession during the growing season (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typical in New Hampshire's less productive lakes and ponds.

  An overabundance of cyanobacteria indicates that there may be an excessive total phosphorus concentration in the lake/pond, or that the ecology is out of balance. Some species of cyanobacteria can be toxic to livestock, pets, wildlife, and humans. (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding cyanobacteria).

Residents should continue to observe the lake/pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria (blue-green algae) have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to “pile” cyanobacteria into scums that accumulate in one section of the lake/pond. If a fall bloom occurs, please contact the VLAP Coordinator.

- **Table 4: pH**

  Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

  pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish. A pH between 6.5 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire’s lakes and ponds is **6.5**, which indicates that the surface waters in state are slightly acidic. For a more detailed explanation regarding pH, please refer to the “Chemical Monitoring Parameters” section of this report.

  The mean pH at the deep spot this season ranged from **6.64** in the hypolimnion to **7.56** in the epilimnion, which means that the water is ***approximately neutral.***

- **Table 5: Acid Neutralizing Capacity**

  Table 5 (Appendix B) presents the current year and historic epilimnetic ANC for each year the lake/pond has been monitored through VLAP.

  Buffering capacity or ANC describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. The mean ANC value for New Hampshire’s lakes and ponds is **6.7 mg/L**, which indicates that many lakes and ponds in the state are “highly sensitive” to acidic inputs. For a more detailed explanation, please refer to the “Chemical Monitoring Parameters” section of this report.

  The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) continues to remain ***greater than*** the state mean of **6.7 mg/L**. Specifically, the lake/pond is classified by DES as ***not sensitive*** to acidic inputs (such as acid precipitation).

- **Table 6: Conductivity**
  Table 6 (Appendix B) presents the current and historic conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current. The mean conductivity value for New Hampshire's lakes and ponds is **62.1 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

  The conductivity has ***increased*** in the lake/pond and inlets since monitoring began. In addition, the in-lake conductivity is ***greater than*** the state mean. Typically, sources of increased conductivity are due to human activity. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake/pond), agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity.

  We recommend that your monitoring group continue to conduct stream surveys and storm event sampling along the inlet(s) with elevated conductivity so that we can determine what may be causing the increases.

  For a detailed explanation on how to conduct rain event and stream surveys, please refer to the 2002 VLAP Annual Report "Special Topic Article", or contact the VLAP Coordinator.

- **Table 8: Total Phosphorus**
  Table 8 (Appendix B) presents the current year and historic total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

- **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**
  Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2003 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters"

section of this report for a more detailed explanation.

The dissolved oxygen concentration was greater than **100 percent** saturation at **0.1 to 4.0** meters at the deep spot on **6/5/03**. Wave action from wind can dissolve atmospheric oxygen into the upper layers of the water column. In addition, layers of algae can also raise the dissolved oxygen in the water column, since oxygen is a by-product of photosynthesis. Considering that the depth of the photic zone (depth to which sunlight can penetrate into the water column) was approximately **4.5** meters on this date (as shown by the Secchi-disk transparency), and that the metalimnion (the layer of rapid decrease in water temperature and increase in density – a place where algae are often found) was located between approximately **3.0** and **5.0** meters, we suspect that an abundance of algae caused the oxygen super saturation.

The dissolved oxygen concentration was ***low in the hypolimnion*** at the deep spot of the lake/pond. As stratified lakes/ponds age, oxygen becomes ***depleted*** in the hypolimnion (the lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion **(as it was this season and in many past seasons)**, the phosphorus that is normally bound up in the sediment may be re-released into the water column.

The ***low*** oxygen level in the hypolimnion is a sign of the lake's/pond's ***aging*** and ***declining*** health. This year the DES biologist conducted the temperature/dissolved oxygen profile in ***JUNE.*** We recommend that the annual biologist visit for the 2004 sampling season be scheduled during ***JUNE*** again, so that we can continue to monitor if oxygen is depleted in the hypolimnion ***early*** in the sampling season.

During this season, and many past sampling seasons the lake/pond has had a lower dissolved oxygen concentration and a higher total phosphorus concentration in the hypolimnion (the lower layer) than in the epilimnion (the upper layer). These data suggest that the process of ***internal total phosphorus loading*** (commonly referred to as ***internal loading***) is occurring in the lake/pond. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion **(as it was this season and in many past seasons)**, the phosphorus that is normally bound up with metals in the sediment may be re-released into the water column. Depleted oxygen concentration in the hypolimnion of thermally stratified lakes/ponds typically occurs as the summer progresses.

Again, this may explain why the phosphorus concentration in the hypolimnion is ***greater*** than the phosphorus concentration in epilimnion. Since an internal source of phosphorus in the lake/pond may be present, it is even more important that watershed residents act proactively to minimize external phosphorus loading from the watershed.

- **Table 11: Turbidity**
  Table 11 (Appendix B) lists the current year and historic data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

  The turbidity of the hypolimnion (lower layer) sample was elevated on **8/14/03**. This suggests that the lake/pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling. When the lake/pond bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. As a result, sediment particles, in addition to internal loading, may have caused elevated phosphorus concentrations in the hypolimnion. When collecting the hypolimnion sample, please check to make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

- **Table 12: Bacteria (*E.coli*)**
  Table 12 lists the current year data for bacteria *(E.coli*) testing. *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage **MAY** be present. If sewage is present in the water, potentially harmful disease-causing organisms may also be present.

  The *E.coli* concentration was ***low*** at inlet #01 on 6/5/03 but ***slightly elevated*** (130 counts/ 100 ml) on 8/14/03. However, the concentration ***was not greater than*** the state standard of 406 counts per 100 mL for recreational waters that are not designated beaches.

  If you are concerned about *E. coli* levels at this station, your monitoring group may want to conduct rain event sampling and bracket sampling in this area. This additional sampling may help us determine the source of the bacteria.

For a detailed explanation on how to conduct rain event and bracketing sampling, please refer to the 2002 VLAP Annual Report "Special Topic Article", or contact the VLAP Coordinator.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

The DES biologist did not conduct a "Sampling Procedures Assessment Audit" for your monitoring group. Your monitoring group continues to do an ***excellent*** job collecting samples. Keep up the good work!

Sample Receipt Checklist:

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

NOTES

- **Monitor's Note (6/5/03):** Hypolimnion sample smelled strongly of sulfur. Inlet #10 had low flow.
  (8/14/03): Olive green clumps of algae all summer. Some weed patches noticeably expanded since last summer. Heavy rain Aug. 9-10. Lost new anchor and rope overboard! 2" of water flow over spillway at outlet.

- **Biologist's Note (8/14/03):** The E. Coli counts at inlet #01 were found to be elevated

USEFUL RESOURCES

Acid Deposition Impacting New Hampshire's Ecosystems, ARD-32, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/ard/ard-32.htm.

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, NHDES-WD 97-8, NHDES Booklet, (603) 271-3503.

Camp Road Maintenance Manual: A Guide for Landowners. KennebecSoil and Water Conservation District, 1992, (207) 287-3901.

Comprehensive Shoreland Protection Act, RSA 483-B, *WD-SP-5,* NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-5.htm.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, WD-SP-1, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-1.htm

Impacts of Development Upon Stormwater Runoff, WD-WQE-7, NHDES Fact Sheet, (603) 271-3503, or www.des.state.nh.us/factsheets/wqe/wqe-7.htm

Iron Bacteria in Surface Water, *WD-BB-18*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-18.htm

Is it Safe to Eat the Fish We Catch? Mercury and Other Pollutants in Fish, NH Department of Health and Human Services pamphlet, 1-800-852-3345, ext. 4664.

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, *WD-BB-9*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-9.htm.

Management of Canada Geese in Suburban Areas: A Guide to the Basics, Draft Report, NJ Department of Environmental Protection Division of Watershed Management, March 2001, www.state.nj.us/dep/watershedmgt/DOCS/BMP_DOCS/Goosedraft.pdf.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, WD-SP-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-2.htm.

Road Salt and Water Quality, WD-WMB-4, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/wmb/wmb-4.htm.

Sand Dumping - Beach Construction, *WD-BB-15*, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-15.htm.

Swimmers Itch, *WD-BB-2*, NHDES Fact Sheet, (603) 271-3503 or *www.des.state.nh.us/factsheets/bb/bb-2.htm.*

Through the Looking Glass: A Field Guide to Aquatic Plants. North American Lake Management Society, 1988, (608) 233-2836 or www.nalms.org.

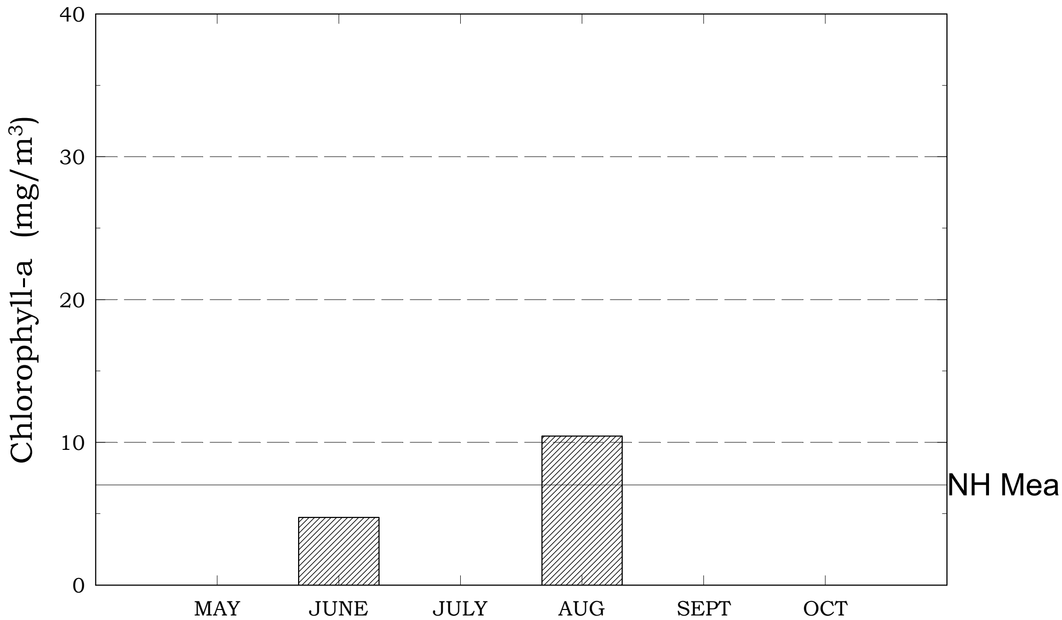
Weed Watchers: An Association to Halt the Spread of Exotic Aquatic Plants, WD-BB-4, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-4.htm.

APPENDIX A

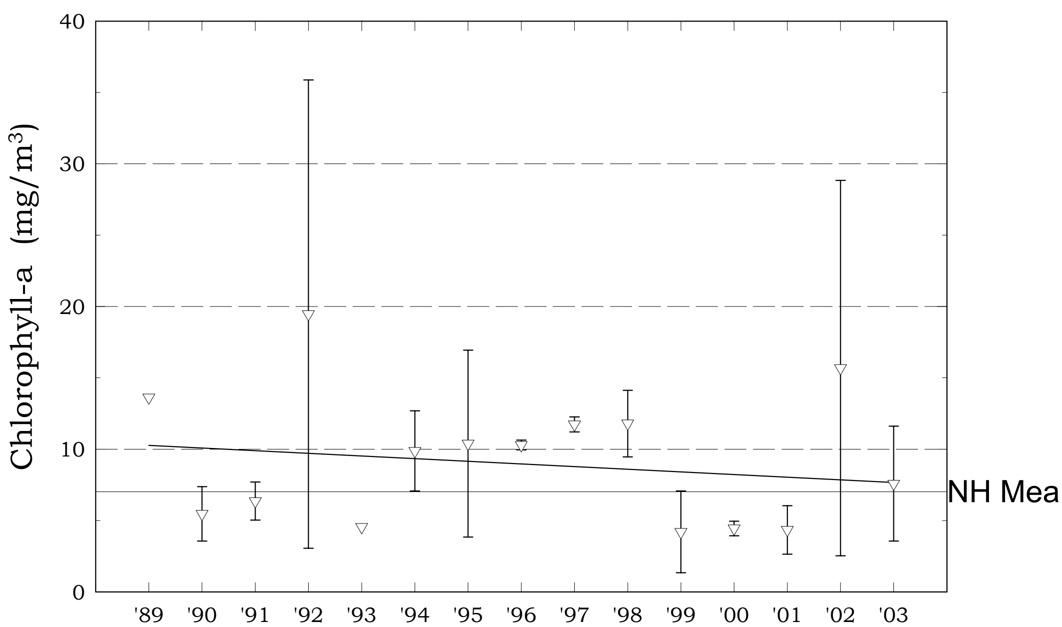
GRAPHS

Partridge Lake, Littleton

Figure 1. Monthly and Historical Chlorophyll-a Results



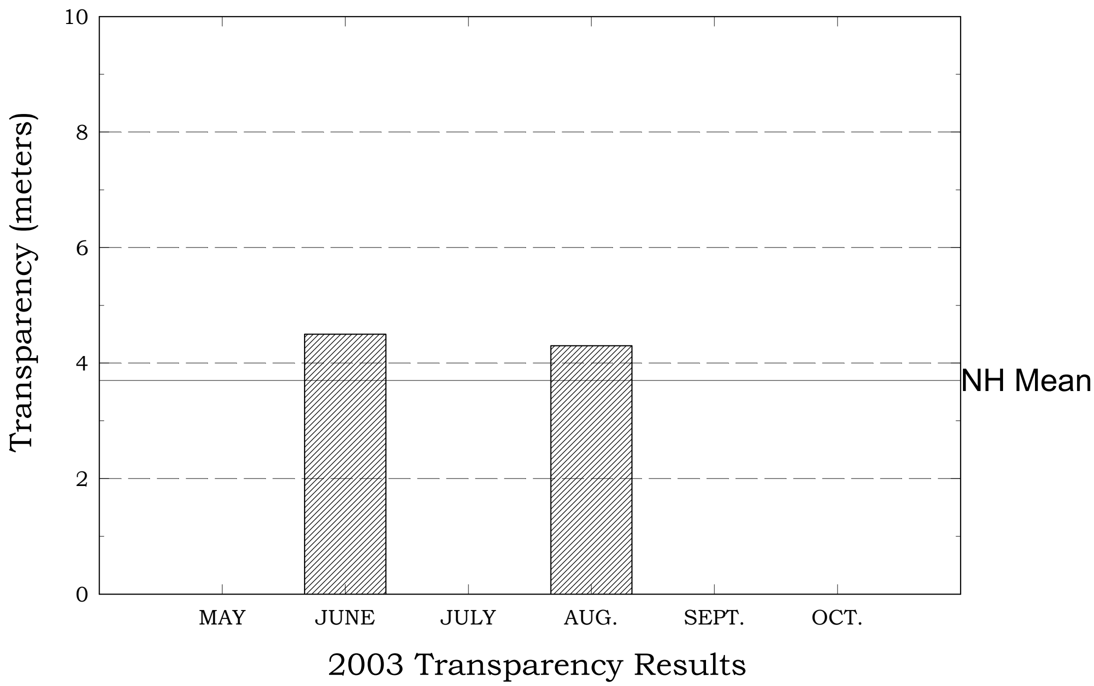
2003 Chlorophyll-a Results

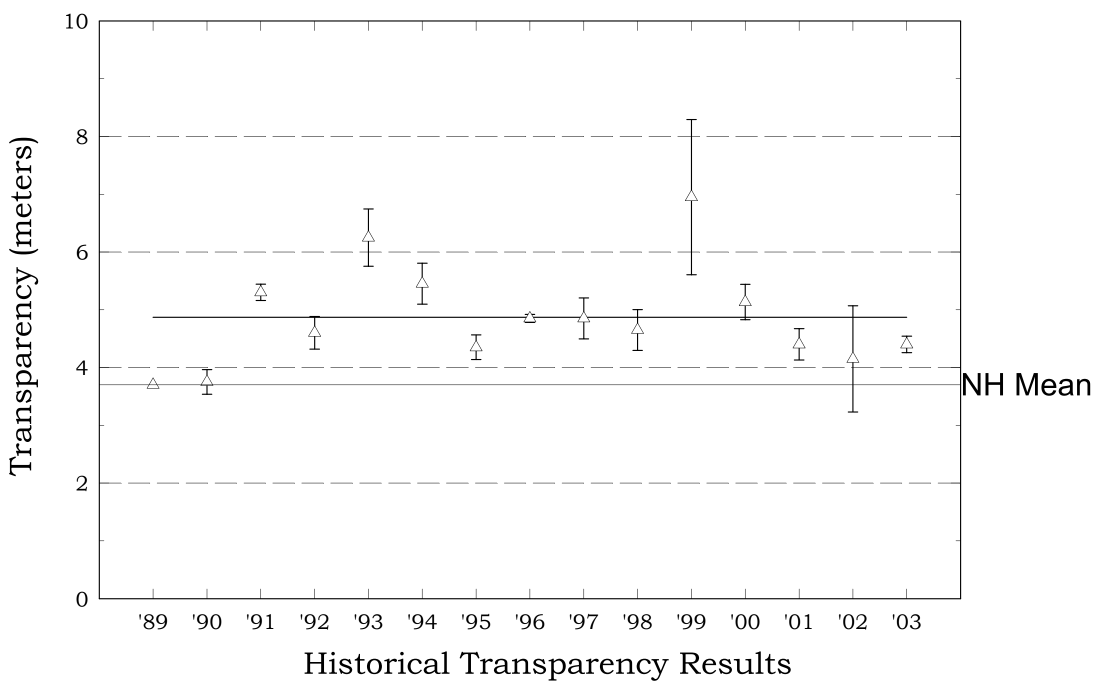


Historical Chlorophyll-a Results

Partridge Lake, Littleton

Figure 2. Monthly and Historical Transparency Results





Partridge Lake, Littleton

Figure 3. Monthly and Historical Total Phosphorus Data.